Blazing a trail for science in the 21st century.
Connecting Tohoku and the world.

The International Linear Collider

JANUARY 2015
Iwate Prefecture
and
Iwate Prefecture Conference
for the Promotion of the ILC

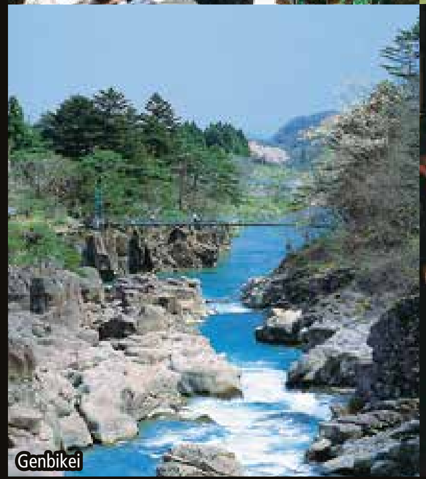
Welcome to The Kitakami Mountain Range, the candidate site for the ILC!

World Heritage Site Hiraizumi

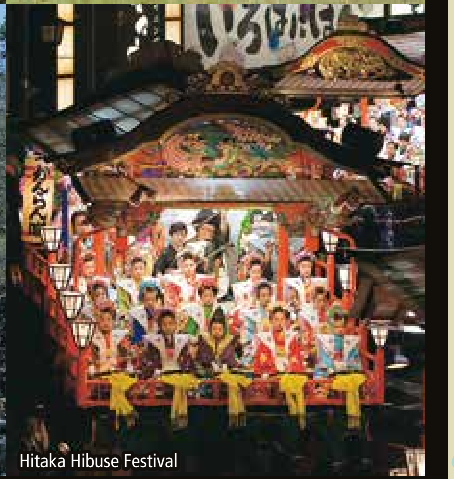
Shinoido(Chuson-ji temple Holding)

Fujiwara Festival Azumakudari

Motsu-ji Temple Gokusui no En



Genbikei



Hitaka Hibuse Festival

Sendai, City of Trees

Pageant of Starlight

Sendai Tanabata Festival

The Nature of Shizukuishi and Hachimantai

Koiwai Farm Lone Cherry Tree and Mt.Iwate

Hachimantai

Appi Kogen Ski Resort

Tono, the Cradle of Folktales

Tono Furusato Mura

Kappa Buchi

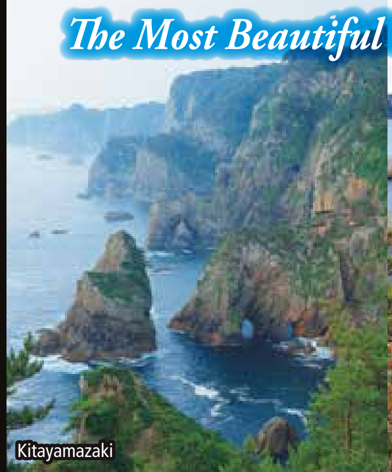
The Land of Famous Poet Kenji Miyazawa

Rasuchijin Kyokai

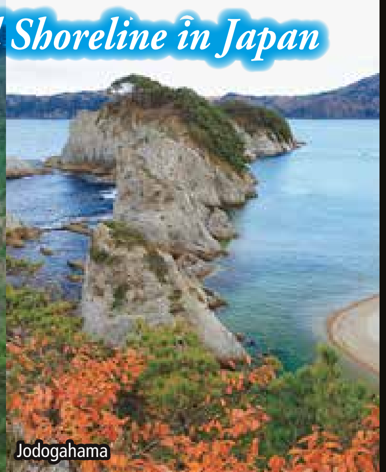
Hanamaki Hot Spring

Hyaku Shika Daigunbu

The Most Beautiful Shoreline in Japan



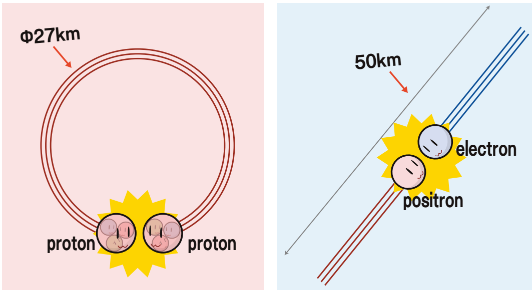
Kitayamazaki



Jodogahama

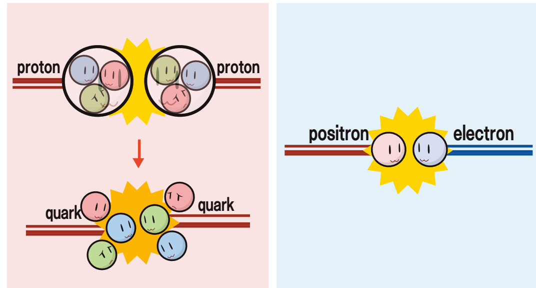
What will we learn from the ILC?

Near Geneva, Switzerland lies the CERN research center that runs the largest accelerator in the world, the Large Hadron Collider(LHC). The LHC is a circular accelerator 27km in circumference, and was the source of huge news in July 2012 when it discovered the Higgs particle. While the LHC collides protons, which are complex particles, the ILC will collide electrons and positrons, which are elementary particles. Colliding them together will create new elementary particles and make it easier to understand their reactions. Scientists can then learn more about the nature of the Higgs particle.



LHC
Large Hadron Collider

ILC
International Linear Collider



LHC
Complex!

ILC
Simple!

Yuki Akimoto［http://higgstan.com/］

What is an accelerator?

An accelerator is a machine that accelerates electrically charged particles. There are many accelerators being used in fields essential to our daily lives, such as industry and medicine.

【Examples of accelerators】
- Electron microscopes: These devices accelerat electrons into a beam over a specimen, and form images by detecting and amplifying the secondary electrons that are generated.
- Positron Emission Tomography (PET): Radioisotopes produced by accelerators are inserted into glucose which is introduced into the body, and emitted positrons can then be detected. It is used in clinical oncology.
- Radiation therapy equipment (cancer treatment): Protons and other particles are accelerated and then aimed at cancerous cells in the body as treatment.

Radiation therapy equipment

Photo : Mitsubishi Heavy Industries, Ltd.

What are elementary particles?

The smallest units that compose matter or force. They are particles that cannot be subdivided any further. Examples are leptons such as electrons and neutrinos, and the quarks that compose protons and neutrons.

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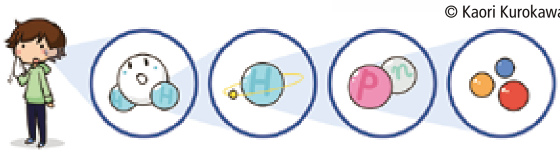


matter　molecule　atom　proton　quark

When will the ILC be built?

The ILC is being planned and designed by an international team of scientists. Here is the history and future schedule of the ILC.

December 2012	Technical Design Report released, outlining details of the accelerator design.
August 2013	Japan decided on the Kitakami mountain range as its candidate site.
2013 – 2018	International negotiations between possible participated countries on the items such as cost distribution Finalize the accelerator design Final site decision
2018	Start construction (Projected to take around 10 years)
In the late 2020's	Start operation.

How much will the ILC cost?

According to the Technical Design Report released in 2012, construction (accelerator and facilities) cost was estimated as 830 billion yen. Annual operating costs will be approximately 36 billion yen.

These costs will be divided among participating countries, but the host country is expected to provide approximately half of the construction cost.

Reconstruction from the Great East Japan and Tsunami and the ILC

The ILC will be facility at the forefront of particle research near Sanriku, Iwate's coastal region. If the ILC's is be built here, the area will be surrounded by an international academic research city where domestic and foreign scientists live and work, and where related industries will also gather. This will cultivate the dreams for the future in our children, and lead to a true reconstruction of not just the devastated areas, but of all Tohoku.

To achieve that aim, Iwate Prefecture is joining forces with Tohoku industry, academia, and government to bring the ILC to Tohoku.

Glossary

＊1 Positron.........The antiparticle of an electron. It has a positive electric charge, and has the same mass as an electron.

＊2 Big Bang ....The cosmic explosion that is thought to have occurred at the beginning of the Universe. The Big Bang theory supposes that the Universe began with an explosion (the 'Big Bang') 13.8 billion years ago followed by the expansion of the Universe in which elementary particles, atoms, molecules, stars, and galaxies were formed.

＊3 Higgs boson...A particle that is thought to fill the Universe just as water fills the sea, and gives mass to elementary particles. Just after the Big Bang, all particles were massless. When the Universe expanded and cooled, the sea of the Higgs field was formed, and it became difficult for the particles to move around, because of the resistance from the sea. It is thought that this difficulty in moving led to the mass of particles.

Overview of the ILC

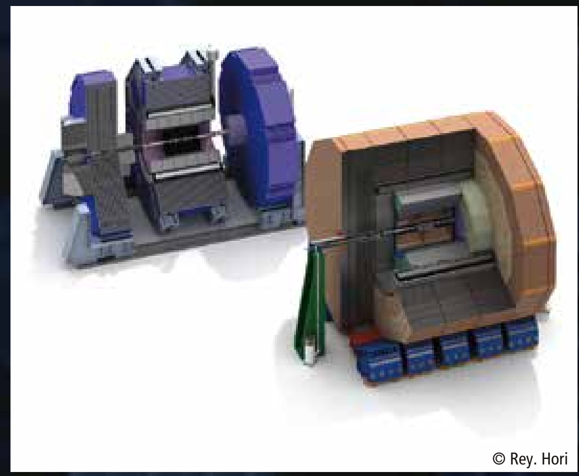

© Rey. Hori

Damping Ring

A damping ring is a closed storage ring that decreases the volume of the particle bunches making up a beam, creating bunches that are denser and more compact. The ILC design has two damping rings, one for the electron beam and one for the positron beam.

Particle Detectors

The particle detectors will record the electron-positron collisions. ILC will have two detectors, ILD and SiD, installed in the center of the accelerator tunnel. Having these two detectors will allow vital cross-checking of the experiments.


© Rey. Hori

Main Linac

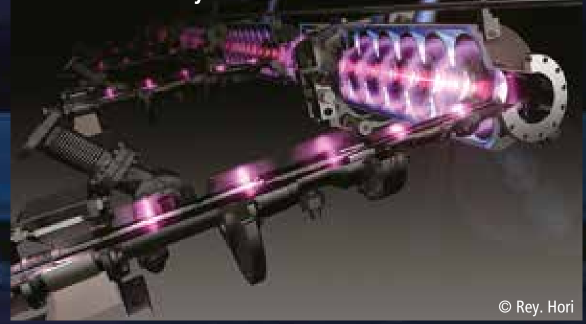

© Rey. Hori

Two principal linear accelerators(main linacs), one for electrons and one for positrons, will accelerate bunches of particles to 99.99999999% of the speed of the light.

〔Cryomodule〕
Each accelerator consists of hollow structures called superconducting cavities, nestled within a series of cooled vessels known as cryomodules. The module uses liquid helium to cool the cavities to minus 271℃ to make them superconducting.

〔Superconductive Accelerating Cavities〕
These important structures are considered the heart of the ILC. They are made of a metal called niobium.

An image of electrons accelerated with in the superconductive accelerator cavity unit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Superconductive Accelerating Cavities


Photo : KEK

Accelerator Tunnel


© Rey. Hori

The accelerator tunnel will have two rooms; one for the main linac (right), and the other for klystrons (left),the device that supplies the accelerator with the electricity it needs.

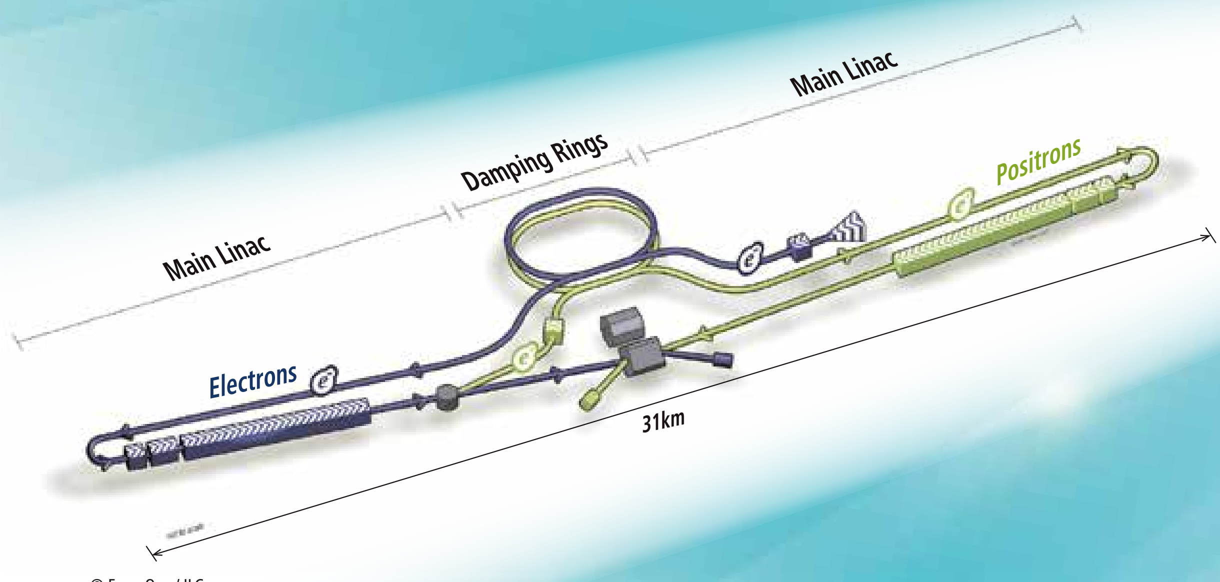
What is the ILC?

The International Linear Collider (or ILC) will be one of the world largest scientific endeavors. Built in a 31km-50km-long tunnel underground, the state-of-the-art electron and positron (*1) linear collider will change our understanding of the universe. Scientists and engineers worldwide are collaborating to realize this unique project. It will be the only one in the world.

How does the ILC work?

In the 31km-50km-long, 100-meter deep underground tunnel,the ILC will accelerate the beam of electrons and positrons to nearly the speed of light, and collide them against each other. The head-on collisions in the central region will recreate the conditions just after the Big Bang (*2) ,revealing what happened at the beginning of the Universe. The collision will also create many diverse particles, including the Higgs boson (*3) , the particle responsible for mass.

By measuring these particles, we will be able to start tackling a mystery that has long plagued the human race – How did mass and the universe come into existence? In addition, accelerator technologies can be used in so many diverse fields such as medicine, biology, the creation of new materials, information/communications, measurements, the environment, and energy.



© Form One / ILC

What are the requirements for the ILC site?

The site must accommodate 31km-50km-long accelerator, the access tunnels, and the large cavern for the particle detectors.

It is absolutely necessary that it be built in stable bedrock that is free of artificial vibrations and active faults so that electrons and positrons can collide with precision.

What happens if the ILC is built here?

If the ILC becomes a reality, about 3,000 scientists and engineers around all over the world will come with their families to live in the area, leading to the creation of an international and multicultural city in Tohoku. An international hub of knowledge will be formed in our backyard, with leading edge research inspiring our children and giving them dreams.

The great features of the Kitakami Mountain Range Site

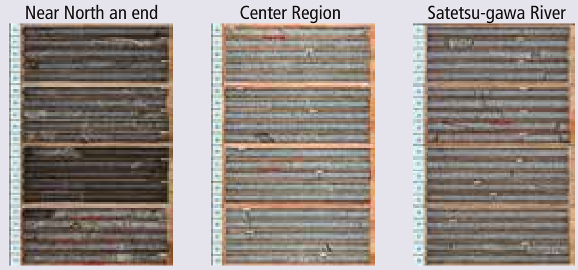
Sturdy granite distributed across 50km, with no active faults

The electrons and positrons to be used in the experiments are extremely small particles. In order to collide them together with precision, the ILC must be built at a site with sturdy bedrock and low vibrations. Plus, the site must keep those features for a length of 31km-50km.

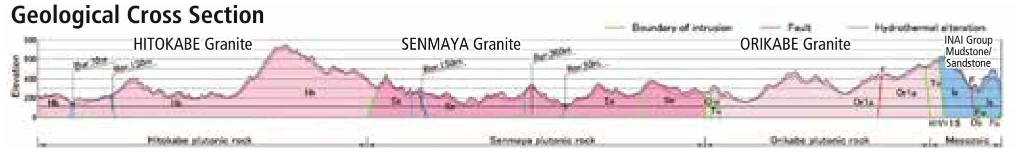
Tohoku's Kitakami mountain is one of the best spots in the world. The underground area of the Kitakami mountains that stretch between Oshu City and Ichinoseki City, Iwate prefecture consist of sturdy granite bedrock. The area stretches from north to south, with Hitokabe bedrock in the north and Senmaya bedrock in the south. Together with Tohoku University, Iwate prefecture conducted a detailed geological survey from December 2012 to the spring of 2013 and confirmed that the Kitakami mountain was a suitable area for the ILC.

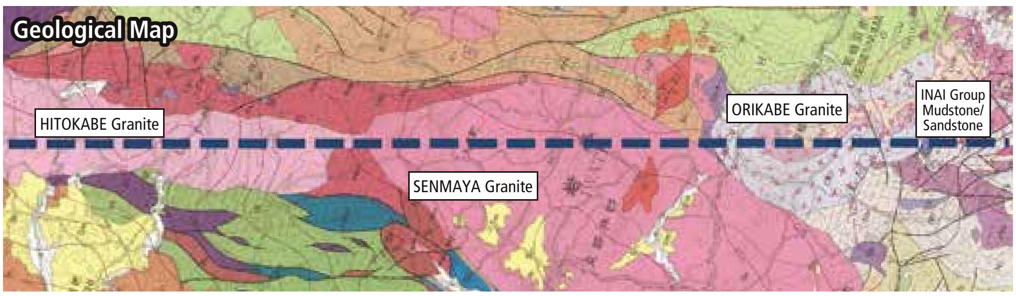
Even though the Tohoku region suffered immense damage from the Great East Japan Earthquake and tsunami, we know that the ground itself is extremely stable. Under the Kitakami mountains holds a national observatory called the Esashi Earth Tides Station, which detected no effect whatsoever from the earthquake on the facility's devices.

Core Samples



Geological Cross Section





Approval number 60635130-A-20131024-001

Kitakami Site Center Region

A great environment for business and society

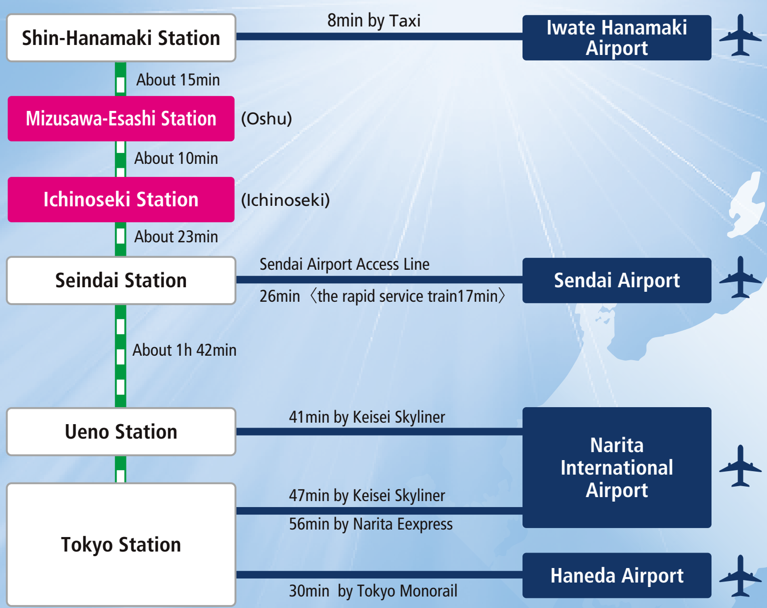
- The site has great international access to and from Sendai, Hanamaki, Narita, and Haneda airports
- Sendai has many urban functions, with Tohoku University cooperating with many other institutions of higher learning and research organizations
- A great place to live because of its cool climate, Sanriku Reconstruction National Park, ski resorts, hot springs, marine sports, and much more
- History, culture, and a bountiful natural environment, with World Heritage sites Hiraizumi (cultural) and Shirakami-Sanchi (natural)
- A safe and reliable area, and a clean and pure environment without pollution

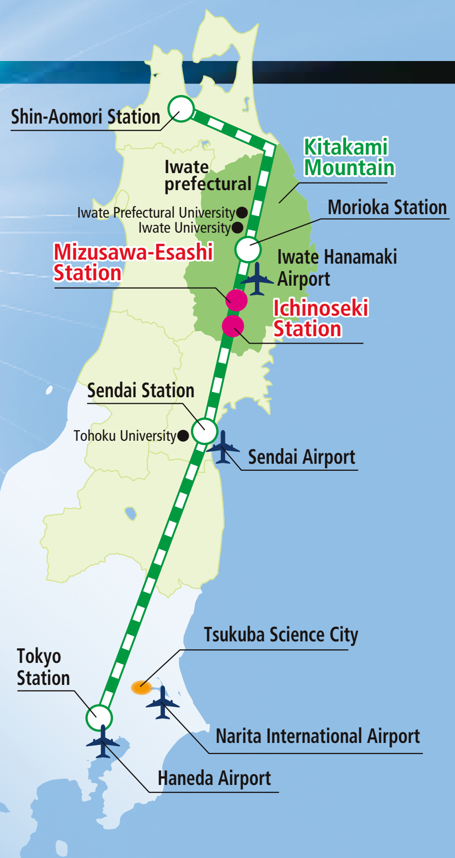
Access

Access to Tokyo from around the world

Access to Ichinoseki / Oshu from Tokyo

■ **When using Shinkansen bullet train** (shortest possible time)





Inquiries

Science and ILC Promotion Division, Department of Policy and Regional Affairs
Iwate Prefectural Government
(020-8507) 10-1, Uchimaru, Morioka City, Iwate Prefecture
TEL 019-629-5217
E-mail AB0009@pref.iwate.jp

※Contacting the Conference
Iwate Prefecture Conference for the Promotion of the ILC
(020-8507) 14-12, Shimizucho, Morioka City, Iwate Prefecture
TEL 019-624-5880
E-mail daihyo@ccimorioka.or.jp